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Dr. Jameel K. Abd & Mustafa N. Dawood

Middle Technical University

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Classification: FOR code: 850699

Language: English

London
Journals Press

LJP Copyright ID: 392851
Print ISSN: 2631-8474
Online ISSN: 2631-8482

London Journal of Engineering Research

Volume 19 | Issue 2 | Compilation 1.0

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This paper deal an AC Transmission system power flow controlled by injecting a compensating voltage in series with the line and injecting reactive power in shunt with the bus. Static Synchronous Series Compensator (SSSC) was considered as a series compensator, and Static Synchronous Compensator (STATCOM) is taken as a shunt compensator, while Unified Power Flow Controller (UPFC) is considered as a series-shunt compensator. This paper covers, in depth, the simulation, and modeling methods required for the study of the steady-state operation of electrical power systems with these flexible AC Transmission Systems (FACTS) controllers. MATLAB® codes were used for the implementation of the three devices in the Newton-Raphson algorithm. Power flow control ranges are evaluated for IRAQI (400kV) National Super Grid System (INSGS). Results are studies and reported are presented to compare the effectiveness of the STATCOM, SSSC, and UPFC.

Keywords: facts, flexible ac transmission systems, static synchronous series compensator, SSSC, static synchronous compensator, statcom, unified power flow controller, upfc.

Author α σ: Dept. Electrical Power Engineering Techniques Middle Technical University Baghdad, Iraq.

I. INTRODUCTION

Result for the high demand for electrical power and the higher industrial loads. This provides the need for electricity generating plants and building new transmission lines, a solution that involves long construction times and is costly to implement. So other ways of high the power transfers of existing transmission facilities while in same time maintaining acceptable levels of stability should be considered and network reliability.

FACTS-devices can be used to improve the stability, increase the transmission capacity and ensure better power quality or dynamic behavior in modern power systems. Their main capabilities are voltage control, reactive power compensation and power flow control [4]. FACTS-devices provide fast control in comparison to conventional devices the same phase shifting transformers with mechanical on-load tap changers or switched compensation.

The first of FACTS-devices was mechanically controlled inductors and capacitors. The second of FACTS devices used the thyristor valve control instead of the mechanical switches. The second of FACTS devices gave improvement the enhancement in concept to mitigate the disturbances and in the speed. The third of FACTS devices uses the concept of voltage source converter-based devices. These devices deliver multi-dimensional control the parameters of the power system [7], [8].

II. POWER FLOW CONTROL

The power transmission line can represent by a two-bus system "k" and "m" in the ordinary form [6]. The active power transmitted between bus nodes k and m is given by:

$$P = \frac{V_m * V_k}{X} \sin(\delta_k - \delta_m$$

Where V$_m$ and V$_k$ are the voltages at the nodes, the angle between the voltages and the line impedance. The power flow can be controlled by altering the voltages at a node, the angle between the end voltages and the impedance between the nodes. The reactive power is given by:

$$Q = \frac{V_k^2}{X} - \frac{V_m * V_k}{X} \cos(\delta_k - \delta_m) \tag{2}$$

III. NEWTON-RAPHSON POWER FLOW

In large-scale power flow studies, the Newton-Raphson [8] has provided successful and strong characteristics. The expressed power flow Newton-Raphson algorithm by the following relationship:

$$\begin{bmatrix} \Delta P \\ \Delta Q \end{bmatrix} = \begin{bmatrix} \frac{\partial P}{\partial \theta} & v\frac{\partial P}{\partial v} \\ \frac{\partial Q}{\partial \theta} & v\frac{\partial Q}{\partial v} \end{bmatrix} \begin{bmatrix} \Delta \theta \\ \frac{\Delta v}{v} \end{bmatrix} \tag{3}$$

Where ΔQ and ΔP are bus reactive and active power mismatches, while V and θ are bus magnitude and angle, respectively.

IV. MODELING OF POWER SYSTEMS WITH STATCOM

The represent of STATCOM by a synchronous voltage source with minimum and maximum of the voltage magnitude limits [4]. The voltage source stands for the fundamental Fourier Series component of the switched voltage waveform at the ac converter terminals of the STATCOM. The bus of the STATCOM is connected is represented as a PV bus, which may be changed to a PQ bus in the case of limits being violated. In this case, the absorbed or generated reactive power would reach the maximum limit. The STATCOM is used to find the mathematical model of the controller for incorporation in power flow algorithms [2]. The STATCOM equivalent circuit shown in Figure 1.

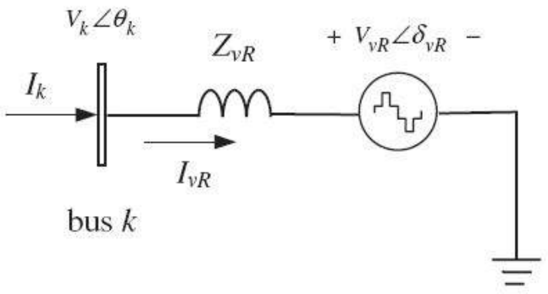


Figure 1: STATCOM Equivalent Circuit.

The power flow equations are derived below for the STATCOM

$$E_{vR} = V_{vR}(\cos\delta_{vR} + j\sin\delta_{vR}) \tag{4}$$

Figure1show a based on the shunt connection, the following equation can be written:

$$S_{vR} = V_{vR} I_{vR}^* = V_{vR} Y_{vR}^* \left(V_{vR}^* - V_k^* \right) \tag{5}$$

The following reactive and active power equations are obtained for the bus k and converter, respectively, after performing some complex operations:

$$P_{vR} = V_{vR}^2 G_{vR} + V_{vR} V_k [G_{vR} \cos(\delta_{vR} - \theta_k) + B_{vR} \sin(\delta_{vR} - \theta_k)] \tag{6}$$

$$Q_{vR} = -V_{vR}^2 B_{vR} + V_{vR} V_k [G_{vR} \sin(\delta_{vR} - \theta_k) - B_{vR} \cos(\delta_{vR} - \theta_k)] \tag{7}$$

$$P_k = V_k^2 G_{vR} + V_k V_{vR} [G_{vR} \cos(\theta_k - \delta_{vR}) + B_{vR} \sin(\theta_k - \delta_{vR})] \tag{8}$$

$$Q_k = -V_k^2 B_{vR} + V_k V_{vR} [G_{vR} \sin(\theta_k - \delta_{vR}) - B_{vR} \cos(\theta_k - \delta_{vR})] \tag{9}$$

The linearized STATCOM model is given below, by using these power equations, where the phase angle and the voltage magnitude are taken to be the state variables [4]:

$$\begin{bmatrix} \Delta P_k \\ \Delta Q_k \\ \Delta P_{vR} \\ \Delta Q_{vR} \end{bmatrix} = \tag{10}$$

The circuit model of the SSSC connected to link k–m is shown in Figure. The objective of the SSSC is to control the active power to a target value [10]. The SSSC is modeled as a voltage source

(VCR) with the angle and adjustable magnitude in series with an impedance. The real part of this impedance represents the coupling transformer and the ohmic losses of the power electronic devices. The imaginary part represents the leakage reactance of the coupling transformer. The admittance (Ys) represents the combined admittances of the SSSC and the line to which it is connected [9] shown in Figure 2. The presence of two new variables (V_{CR} and δ_{CR}) to the power flow problem. Thus, two new equations are needed for power flow solution. One of these equations is found by (P_k) equating to its target value, and the other one is found using the fact that the power consumed by the source (V_{CR}) is equal to zero. The power flow equations for all buses of the power system with SSSC in place are the same as those of the system without the SSSC, excluding buses k and m [8].

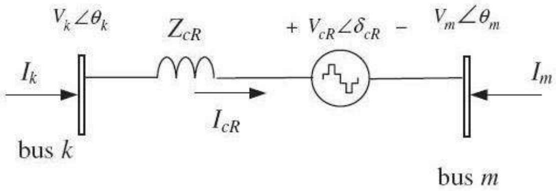


Figure 2: The Equivalent Circuit of an SSSC.

The SSSC voltage source is:

$$E_{cR} = V_{cR}(\cos\delta_{cR} + j\sin\delta_{cR}) \quad (11)$$

The phase angle(δ_{CR}) and magnitude (V_{CR}) of the voltage source representing the series converter are controlled between limits ($V_{cR,min} \leq V_{cR} \leq V_{cR,max}$) and ($0 \leq \delta_{cR} \leq 2\pi$) respectively. From the equivalent circuit shown in Figure 2 and Equations (11), the active and reactive power equations at bus k are:

$$\begin{aligned} P_k = {} & V_k^2 G_{kk} + V_k V_m[G_{km}\cos(\theta_k - \theta_m) \\ & + B_{km}\sin(\theta_k - \theta_m)] + V_k V_{cR}[G_{km}\cos(\theta_k - \delta_{cR}) \\ & + B_{km}\sin(\theta_k - \delta_{cR})] \end{aligned} \quad (12)$$

$$\begin{aligned} Q_k = {} & -V_k^2 B_{kk} + V_k V_m[G_{km}\sin(\theta_k - \theta_m) \\ & - B_{km}\cos(\theta_k - \theta_m)] + V_k V_{cR}[G_{km}\sin(\theta_k - \delta_{cR}) \\ & - B_{km}\cos(\theta_k - \delta_{cR})] \end{aligned} \quad (13)$$

And for series converter are:

$$\begin{aligned} P_{cR} = {} & V_{cR}^2 G_{mm} + V_{cR} V_k[G_{km}\cos(\delta_{cR} - \theta_k) \\ & + B_{km}\sin(\delta_{cR} - \theta_k)] \end{aligned} \quad (14)$$

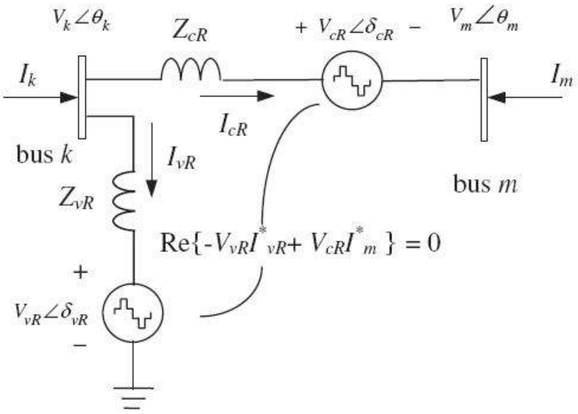
$$\begin{aligned} & + V_{cR} V_m[G_{mm}\cos(\delta_{cR} - \theta_m) \\ & + B_{mm}\sin(\delta_{cR} - \theta_m)] \end{aligned} \quad (15)$$

The system of equations is as follows:

$$\begin{bmatrix} \Delta P_k \\ \Delta P_m \\ \Delta Q_k \\ \Delta Q_m \\ \Delta P_{mk} \\ \Delta Q_{mk} \end{bmatrix} = \begin{bmatrix} \frac{\partial P_k}{\partial \theta_k} & \frac{\partial P_k}{\partial \theta_m} & \frac{\partial P_k}{\partial V_k}V_k & \frac{\partial P_k}{\partial V_m}V_m & \frac{\partial P_k}{\partial \delta_{cR}} & \frac{\partial P_k}{\partial V_{cR}}V_{cR} \\ \frac{\partial P_m}{\partial \theta_k} & \frac{\partial P_m}{\partial \theta_m} & \frac{\partial P_m}{\partial V_k}V_k & \frac{\partial P_m}{\partial V_m}V_m & \frac{\partial P_m}{\partial \delta_{cR}} & \frac{\partial P_m}{\partial V_{cR}}V_{cR} \\ \frac{\partial Q_k}{\partial \theta_k} & \frac{\partial Q_k}{\partial \theta_m} & \frac{\partial Q_k}{\partial V_k}V_k & \frac{\partial Q_k}{\partial V_m}V_m & \frac{\partial Q_k}{\partial \delta_{cR}} & \frac{\partial Q_k}{\partial V_{cR}}V_{cR} \\ \frac{\partial Q_m}{\partial \theta_k} & \frac{\partial Q_m}{\partial \theta_m} & \frac{\partial Q_m}{\partial V_k}V_k & \frac{\partial Q_m}{\partial V_m}V_m & \frac{\partial Q_m}{\partial \delta_{cR}} & \frac{\partial Q_m}{\partial V_{cR}}V_{cR} \\ \frac{\partial P_{mk}}{\partial \theta_k} & \frac{\partial P_{mk}}{\partial \theta_m} & \frac{\partial P_{mk}}{\partial V_k}V_k & \frac{\partial P_{mk}}{\partial V_m}V_m & \frac{\partial P_{mk}}{\partial \delta_{cR}} & \frac{\partial P_{mk}}{\partial V_{cR}}V_{cR} \\ \frac{\partial Q_{mk}}{\partial \theta_k} & \frac{\partial Q_{mk}}{\partial \theta_m} & \frac{\partial Q_{mk}}{\partial V_k}V_k & \frac{\partial Q_{mk}}{\partial V_m}V_m & \frac{\partial Q_{mk}}{\partial \delta_{cR}} & \frac{\partial Q_{mk}}{\partial V_{cR}}V_{cR} \end{bmatrix} \begin{bmatrix} \Delta\theta_k \\ \Delta\theta_m \\ \frac{\Delta V_k}{V_k} \\ \frac{\Delta V_m}{V_m} \\ \Delta\delta_{cR} \\ \frac{\Delta V_{cR}}{V_{cR}} \end{bmatrix} \quad (16)$$

V. MODELING OF POWER SYSTEMS WITH UPFC

An equivalent circuit of UPFC consisting of two coordinated synchronous voltage sources should represent the UPFC adequately. An equivalent circuit of UPFC shown in Figure 3. The synchronous voltage sources represent the fundamental Fourier series component of the switched voltage waveforms at the AC converter terminals of the UPFC [7].



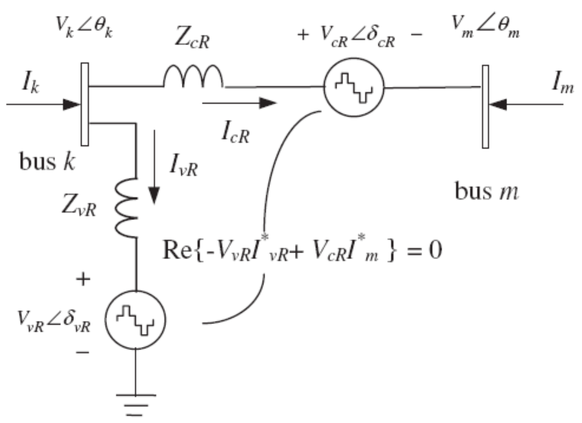


Figure 3: UPFC Equivalent Circuit.

The UPFC voltage sources are:

$$E_{vR} = V_{vR}(\cos\delta_{vR} + j\sin\delta_{vR}) \tag{17}$$

$$E_{cR} = V_{cR}(\cos\delta_{cR} + j\sin\delta_{cR}) \tag{18}$$

Where (δ_{vR}) and (V_{vR}) are the controllable phase angle ($0 \le \delta_{vR} \le 2\pi$) and magnitude ( ) of the voltage source representing the shunt converter. The phase angle (δ_{cR}) and magnitude (V_{cR}) of the voltage source representing the series converter are controlled between limits angle ($0 \le \delta_{cR} \le 2\pi$) and ($V_{cR,min} \le V_{cR} \le V_{cR,max}$) respectively. The phase angle of the series injected voltage determines the mode of power flow control. If (δ_{cR}) is in phase with the nodal voltage angle θ_k , the UPFC regulates the terminal voltage. If is in quadrature with respect to θ_k , it controls active power flow, acting as a phase shifter. If is in quadrature with the line current angle then it controls active power flow, acting as a variable series compensator [3]. At any other value of/, the UPFC operates as a combination of the voltage regulator, variable series compensator, and phase shifter. The magnitude of the series-injected voltage determines the power flow be controlled. Based on Equations (17) and (18) and the equivalent circuit shown in Figure 3, the reactive and active power equations are at bus k [4]:

$$\begin{aligned} P_k = {} & V_k^2 G_{kk} + V_k V_m [G_{km}\cos(\theta_k - \theta_m) \\ & + B_{km}\sin(\theta_k - \theta_m)] + V_k V_{cR} [G_{km}\cos(\theta_k - \delta_{cR}) \\ & + B_{km}\sin(\theta_k - \delta_{cR})] + V_k V_{vR} [G_{vR}\cos(\theta_k - \delta_{vR}) \\ & + B_{vR}\sin(\theta_k - \delta_{vR})] \end{aligned} \tag{19}$$

$$\begin{aligned} Q_k = {} & -V_k^2 B_{kk} + V_k V_m [G_{km}\sin(\theta_k - \theta_m) \\ & - B_{km}\cos(\theta_k - \theta_m)] + V_k V_{cR} [G_{km}\sin(\theta_k - \delta_{cR}) \\ & - B_{km}\cos(\theta_k - \delta_{cR})] + V_k V_{vR} [G_{vR}\sin(\theta_k - \delta_{vR}) \\ & - B_{vR}\cos(\theta_k - \delta_{vR})] \end{aligned} \tag{20}$$

At bus m:

$$\begin{aligned} P_k = {} & V_m^2 G_{mm} + V_m V_k [G_{mk}\cos(\theta_m - \theta_k) \\ & + B_{mk}\sin(\theta_m - \theta_k)] + \\ & V_m V_{cR} [G_{mm}\cos(\theta_m - \delta_{cR}) + \\ & B_{mm}\sin(\theta_m - \delta_{cR})] \end{aligned} \tag{21}$$

$$\begin{aligned} Q_k = {} & -V_m^2 B_{mm} + V_m V_k [G_{mk}\sin(\theta_m - \theta_k) \\ & - B_{mk}\cos(\theta_m - \theta_k)] + \\ & V_m V_{cR} [G_{mm}\sin(\theta_m - \delta_{cR}) - \\ & B_{mm}\cos(\theta_m - \delta_{cR})] \end{aligned} \tag{22}$$

Series converter:

$$\begin{aligned} P_{cR} = {} & V_{cR}^2 G_{mm} + V_{cR} V_k [G_{km}\cos(\delta_{cR} - \theta_k) \\ & + B_{km}\sin(\delta_{cR} - \theta_k)] + \\ & V_{cR} V_m [G_{mm}\cos(\delta_{cR} - \theta_m) + \\ & B_{mm}\sin(\delta_{cR} - \theta_m)] \end{aligned} \tag{23}$$

Shunt converter:

$$\begin{aligned} Q_{cR} = {} & -V_{cR}^2 B_{mm} + V_{cR} V_k [G_{km}\sin(\delta_{cR} - \theta_k) \\ & - B_{km}\cos(\delta_{cR} - \theta_k)] + \\ & V_{cR} V_m [G_{mm}\sin(\delta_{cR} - \theta_m) - \\ & B_{mm}\cos(\delta_{cR} - \theta_m)] \end{aligned} \tag{24}$$

$$\begin{aligned} P_{vR} = {} & -V_{vR}^2 G_{vR} + V_{vR} V_k [G_{vR}\cos(\delta_{vR} - \theta_k) \\ & + B_{vR}\sin(\delta_{vR} - \theta_k)] \end{aligned} \tag{25}$$

$$\begin{aligned} Q_{vR} = {} & V_{vR}^2 B_{vR} + V_{vR} V_k [G_{vR}\sin(\delta_{vR} - \theta_k) \\ & - B_{vR}\cos(\delta_{vR} - \theta_k)] \end{aligned} \tag{26}$$

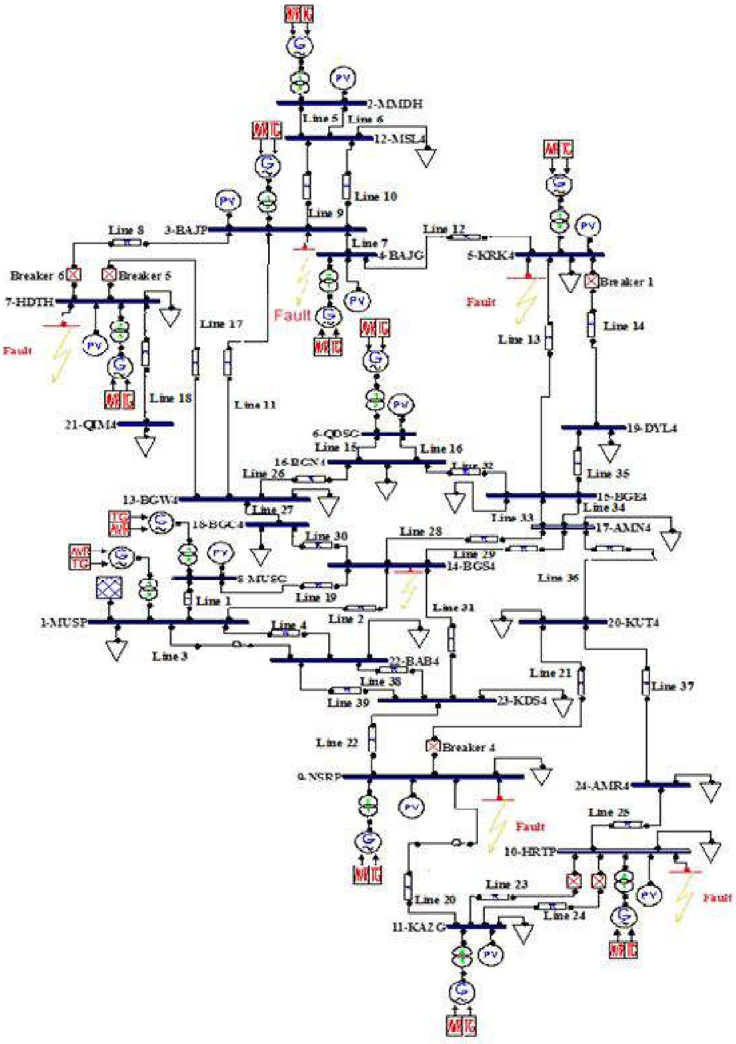
The equations of UPFC power, in linearized form, are combined with those of the AC network. For the case when the UPFC controls the following parameters:

(1) Voltage magnitude at the shunt converter terminal (bus k),
(2) Active power flow from bus m to bus k,
(3) Reactive power injected at bus m and taking bus m to be a PQ bus. The linearized system of equation is as follows [4]:

$$
\begin{bmatrix} \Delta P_k \\ \Delta P_m \\ \Delta Q_k \\ \Delta Q_m \\ \Delta P_{mk} \\ \Delta Q_{mk} \\ \Delta P_{bb} \end{bmatrix} =
\begin{bmatrix}
\frac{\partial P_k}{\partial \theta_k} & \frac{\partial P_k}{\partial \theta_m} & \frac{\partial P_k}{\partial V_{vR}} V_{vR} & \frac{\partial P_k}{\partial V_m} V_m & \frac{\partial P_k}{\partial \delta_{cR}} & \frac{\partial P_k}{\partial V_{cR}} V_{cR} & \frac{\partial P_k}{\partial \delta_{vR}} \\
\frac{\partial P_m}{\partial \theta_k} & \frac{\partial P_m}{\partial \theta_m} & 0 & \frac{\partial P_m}{\partial V_m} V_m & \frac{\partial P_m}{\partial \delta_{cR}} & \frac{\partial P_m}{\partial V_{cR}} V_{cR} & 0 \\
\frac{\partial Q_k}{\partial \theta_k} & \frac{\partial Q_k}{\partial \theta_m} & \frac{\partial Q_k}{\partial V_{vR}} V_{vR} & \frac{\partial Q_k}{\partial V_m} V_m & \frac{\partial Q_k}{\partial \delta_{cR}} & \frac{\partial Q_k}{\partial V_{cR}} V_{cR} & \frac{\partial Q_k}{\partial \delta_{vR}} \\
\frac{\partial Q_m}{\partial \theta_k} & \frac{\partial Q_m}{\partial \theta_m} & 0 & \frac{\partial Q_m}{\partial V_m} V_m & \frac{\partial Q_m}{\partial \delta_{cR}} & \frac{\partial Q_m}{\partial V_{cR}} V_{cR} & 0 \\
\frac{\partial P_{mk}}{\partial \theta_k} & \frac{\partial P_{mk}}{\partial \theta_m} & 0 & \frac{\partial P_{mk}}{\partial V_m} V_m & \frac{\partial P_{mk}}{\partial \delta_{cR}} & \frac{\partial P_{mk}}{\partial V_{cR}} V_{cR} & 0 \\
\frac{\partial Q_{mk}}{\partial \theta_k} & \frac{\partial Q_{mk}}{\partial \theta_m} & 0 & \frac{\partial Q_{mk}}{\partial V_m} V_m & \frac{\partial Q_{mk}}{\partial \delta_{cR}} & \frac{\partial Q_{mk}}{\partial V_{cR}} V_{cR} & 0 \\
\frac{\partial P_{bb}}{\partial \theta_k} & \frac{\partial P_{bb}}{\partial \theta_m} & \frac{\partial P_{bb}}{\partial V_{vR}} V_{vR} & \frac{\partial P_{bb}}{\partial V_m} V_m & \frac{\partial P_{bb}}{\partial \delta_{cR}} & \frac{\partial P_{bb}}{\partial V_{cR}} V_{cR} & \frac{\partial P_{bb}}{\partial \delta_{vR}}
\end{bmatrix}
\begin{bmatrix} \Delta \theta_k \\ \Delta \theta_m \\ \frac{\Delta V_{vR}}{V_{vR}} \\ \frac{\Delta V_m}{V_m} \\ \Delta \delta_{cR} \\ \frac{\Delta V_{cR}}{V_{cR}} \\ \Delta \delta_{vR} \end{bmatrix} \tag{27}
$$

VI. SIMULATION RESULTS

IRAQI (400kV) National Super Grid System (INSGS) network is tested with or without UPFC, SSSC, and STATCOM, to check real Power Losses and reactive Power Losses in the system. In the table (1) we will note the results with and without adding UPFC in all the lines of the system. In the table (2) we will note the results with and without adding SSSC in all the lines of the system. In the table (3) we will note the results with and without adding STATCOM in all the bus of the system.



	Line No.	Location of SSSC	Total Generation System [p.u]		Total Load System [p.u]		Total Real Losses System p.u	Total Reactive Losses System p.u
		Bus number	Real	Reactive	Real	Reactive		
System with SSSC	1	1-8	58.481	21.9332	58	28.5138	0.48095	-6.5806
	2	1-14	58.4567	22.0626	58	28.5138	0.45978	-6.4512
	3	1-22	58.4671	21.0039	58	28.5138	0.41709	-65099
	4	1-22	58.4671	21.0039	58	28.5138	0.46709	-6.5099
	5	2-12	58.451	22.00711	58	28.5138	0.45999	-6.4427
	6	2-12	58.451	22.00711	58	28.5138	0.45999	-6.4427
	7	3-4	58.4808	21.9181	58	28.5138	0.4808	-6.5956
	8	3-7	58.4509	22.3507	58	28.5138	0.4509	-6.1631
	9	3-12	58.4796	22.4408	58	28.5138	0.47987	-6.043
	10	3-12	58.4796	22.4408	58	28.5138	0.47987	-6.043
	11	3-13	58.4209	22.425	58	28.5138	0.42092	-6.0213
	12	4-5	58.4634	22.1403	58	28.5138	0.46335	-6.3735
	13	5-15	58.4549	22.5858	58	28.5138	0.42493	-5.928
	14	5-19	58.4777	21.9261	58	28.5138	0.4777	-6.5877
	15	6-16	58.4777	21.9261	58	28.5138	0.4777	-6.5877
	16	6-16	58.471	21.5852	58	28.5138	0.47095	-5.9286
	17	7-13	58.4775	22.3015	58	28.5138	0.47746	-6.2124
	18	7-21	58.458	22.0481	58	28.5138	0.45795	-6.4657
	19	8-14	58.4178	22.3877	58	28.5138	0.44777	-6.1261
	20	9-11	58.4301	22.3909	58	28.5138	0.43012	-6.1229
	21	9-20	58.4427	22.3875	58	28.5138	0.44265	-6.1263
	22	9-23	58.4806	22.0792	58	28.5138	0.48063	-6.4346
	23	10-11	58.4806	22.0792	58	28.5138	0.48063	-6.4346
	24	10-11	58.4651	22.2671	58	28.5138	0.46509	-6.2467
	25	10-24	58.479	22.0344	58	28.5138	0.47897	-6.4794
	26	13-16	58.479	22.0344	58	28.5138	0.47897	-6.4794
	27	13-18	58.4808	22.0024	58	28.5138	0.48077	-6.5115
	28	14-17	58.4751	22.0284	58	28.5138	0.47511	-6.4854
	29	14-17	58.4751	22.0284	58	28.5138	0.47511	-6.854
	30	14-18	58.4747	22.0448	58	28.5138	0.4747	-6.4691
	31	14-23	58.4774	22.3482	58	28.5138	0.47739	-6.1656
	32	15-16	58.4781	21.9391	58	28.5138	0.47808	-6.5747
	33	15-17	58.4803	21.9774	58	28.5138	0.48025	-6.5364
	34	15-17	58.4803	21.9774	58	28.5138	0.48025	-6.5364
	35	15-19	58.4797	22.0342	58	28.5138	0.47964	-6.4796
	36	17-20	58.4409	21.8813	58	28.5138	0.44088	-6.6325
	37	20-24	58.4757	22.5755	58	28.5138	0.47568	-5.9383
	38	22-23	58.4686	22.2206	58	28.5138	0.46859	-6.2932
	39	22-23	58.4686	22.2206	58	28.5138	0.4685	-6.2932
without SSSC			58.481	21.9154	58	28.5138	0.48095	-6.5984

	Line No.	Location Of UPFC	Total Generation System [p.u]					
		Bus number	Real	Reactive	Real	Reactive		
System with UPFC	1	1-8	58.481	21.9332	58	28.5138	0.48095	-6.5806
	2	1-14	58.4577	22.0453	58	28.5138	0.47774	-6.4685
	3	1-22	58.4657	21.9898	58	28.5138	0.45166	-6.524
	4	1-22	58.4657	21.9898	58	28.5138	0.46566	-6.463
	5	2-12	58.4579	22.0508	58	28.5138	0.49793	-6.463
	6	2-12	58.4579	22.0508	58	28.5138	0.45793	-6.463
	7	3-4	58.4808	21.9181	58	28.5138	0.4808	-6.5957
	8	3-7	58.4493	22.3226	58	28.5138	0.49432	-6.1912
	9	3-12	58.4797	22.4697	58	28.5138	0.47965	-6.0441
	10	3-12	58.4797	22.4697	58	28.5138	0.47965	-6.0441
	11	3-13	58.4133	22.429	58	28.5138	0.41333	-6.0848
	12	4-5	58.4627	22.1237	58	28.5138	0.46272	-6.3902
	13	5-15	58.4513	22.5577	58	28.5138	0.45129	-5.9561
	14	5-19	58.4546	22.4431	58	28.5138	0.45458	-6.0707
	15	6-16	58.4773	21.9217	58	28.5138	0.47731	-6.5921
	16	6-16	58.4773	21.9217	58	28.5138	0.47731	-6.5921
	17	7-13	58.4697	22.5743	58	28.5138	0.4697	-5.9395
	18	7-21	58.4775	22.2983	58	28.5138	0.47746	-6.2155
	19	8-14	58.456	22.0295	58	28.5138	0.45603	-6.4843
	20	9-11	58.4149	22.3283	58	28.5138	0.41489	-6.1855
	21	9-20	58.4268	22.3348	58	28.5138	0.46675	-6.179
	22	9-23	58.4417	22.3498	58	28.5138	0.48165	-6.164
	23	10-11	58.4806	22.0797	58	28.5138	0.48063	-6.4341
	24	10-11	58.4806	22.0797	58	28.5138	0.48063	-6.4341
	25	10-24	58.4645	22.2456	58	28.5138	0.46444	-6.2682
	26	13-16	58.4786	22.0289	58	28.5138	0.47855	-6.4849
	27	13-18	58.4808	22.0019	58	28.5138	0.48078	-6.5119
	28	14-17	58.4747	22.024	58	28.5138	0.47464	-6.4898
	29	14-17	58.4747	22.024	58	28.5138	0.47464	-6.4898
	30	14-18	58.4746	22.0397	58	28.5138	0.47458	-6.4742
	31	14-23	58.4767	22.3433	58	28.5138	0.47674	-6.1705
	32	15-16	58.478	21.936	58	28.5138	0.47797	-6.5778
	33	15-17	58.4803	21.9775	58	28.5138	0.48025	-6.5364
	34	15-17	58.4803	21.9775	58	28.5138	0.48025	-6.5364
	35	15-19	58.4796	22.0327	58	28.5138	0.47961	-6.4811
	36	17-20	58.4349	21.8401	58	28.5138	0.43492	-6.6737
	37	20-24	58.4751	22.5645	58	28.5138	0.4751	-5.9493
	38	22-23	58.467	22.2074	58	28.5138	0.46701	-6.3064
	39	22-23	58.467	22.2074	58	28.5138	0.46701	-6.3064
Without UPFC			58.481	21.9154	58	28.5138	0.48095	-6.5984

	Location of STATCOM	Total Generation system [p.u]		Total Load system [p.u]		Total Real Losses System p.u	Total Reactive Losses system p.u
	Bus number	Real	Reactive	Real	Reactive		
	Without STATCOM	58.481	21.9154	58	28.5138	0.48095	-6.5984
System With STATCOM	1	58.462	21.9479	58	28.5138	0.46201	-6.5659
	2	58.4528	21.9915	58	28.5138	0.45278	-6.5278
	3	58.4724	22.2304	58	28.5138	0.4724	-6.2834
	4	58.4657	21.9177	58	28.5138	0.4808	-6.5961
	5	58.4409	22.4679	58	28.5138	0.44086	-6.0459
	6	58.4763	22.9089	58	28.5138	0.47629	-6.605
	7	58.4459	22.2479	58	28.5138	0.44589	-6.2659
	8	58.4459	22.2479	58	28.5138	0.44589	-6.2659
	9	58.4395	22.2566	58	28.5138	0.45953	-6.2572
	10	58.4632	22.1926	58	28.5138	0.46315	-6.3212
	11	58.4188	22.1762	58	28.5138	0.41878	-6.3376
	12	58.3924	22.2304	58	28.5138	0.4924	-6.2834
	13	58.475	22.3282	58	28.5138	0.4794	-6.1856
	14	58.4409	22.4679	58	28.5138	0.44086	-6.0459
	15	58.4773	21.9217	58	28.5138	0.47731	-6.5003
	16	58.4166	21.7013	58	28.5138	0.45657	-6.8125
	17	58.4745	22.026	58	28.5138	0.47447	-6.4879
	18	58.4796	22.0292	58	28.5138	0.47955	-6.4846
	19	58.4166	22.7013	58	28.5138	0.46657	-6.8125
	20	58.4166	22.7013	58	28.5138	0.41657	-6.8125
	21	58.4775	22.2908	58	28.5138	0.47746	-6.223
	22	58.462	22.9479	58	28.5138	0.46201	-6.5659
	23	58.4627	22.1664	58	28.5138	0.4627	-6.3474
	24	58.4627	22.1664	58	28.5138	0.4627	-6.3474

VII. CONCLUSION

The result explained that UPSC is the best facts devices that make the system reduce losses and high performance, while SSSC and STATCOM have a weak effect on controlling power losses than UPFC instillation. This procedure was applied to the IRAQI (400kV) National Super Grid System (INSGS) system and implemented using the MATLAB® software package. From results of optimal location, it is observed for UPFC and SSSC at lines (3,11,13,20,36) and STATCOM near bus (1,3,5,11,20)

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